Iglesias J. (2011). Other species diversification in Europe. In: "Seafarming Tomorrow": Summary document of Aquaculture Europe 2010 (Porto) compiled by the European Aquaculture Society. Pg :18-20.

Although in the area of species diversification finfish are the most widely studied group, other taxonomic organisms like cephalopods (octopus, cuttlefish), echinoderms (sea urchin), crustaceans (king crab, spider crab and shrimp), ornamental fish (sea horse) or seaweeds (laminarians) are also commercially produced or investigated in Europe.
Fish aquaculture represents about 50% of the total world production in volume. After, seaweeds represent 23%, molluscs 19%, crustaceans 7%, amphibians and reptiles 0.5% and other invertebrates 0.4% of the total. Japanese laminarians, wakame (*Undaria pinnatifera*) is the main species produced in the world (4.7 million tonnes in 2008); the second is carp (*Hypophthalmichthys molitrix* (3.8 million tonnes). However related to their commercial value, the white shrimp (*Litopenaeus vannamei*) is the first and the Atlantic salmon (*Salmo salar*), the second in importance.

Cephalopods

Considering the positive biological characteristics and the worldwide industrial interest in the market (high demand and market price), cephalopods are considered as strong candidates for diversification in the near future in marine aquaculture. On-growing commercial trials have been developed at a small scale by fishermen associations or small companies in Spain and in other Mediterranean countries. They growth wild individuals caught in the sea for 4 months in floating cages to attain the marketable size. However, nowadays the main bottleneck of *Octopus vulgaris* culture is the rearing of paralarvae, which shows very high mortality rates during the first two months of life. The whole life cycle was only successful at an experimental scale using artemia and live crabs zoea (Iglesias et al. 2004), but to develop this technique to a commercial level is necessary to define the nutritional requirement of the species and the use of an adequate prey for first feeding. Fatty acid requirements have been studied in depth in octopus rearing experiments but the role of other nutritional components like proteins, amino acids or phospholipids must be defined to solve the problem of **19** Aquaculture Europe 2010

larval rearing. The use of other octopus species with no planctonic stage like *Octopus maya* may be a different strategy to solve the problem. For other cephalopod species like *Sepia officinalis* the hatchling stage is the main culture problem due to the high mortality observed but also the need of a live prey is also an important barrier. In consequence, the use of suitable inert diets for first feeding of juveniles must be priority in the near future to attain the commercial level production.

Crustaceans

Regarding crustaceans, shrimps are the most important species in the market. The white shrimp (*Litopenaeus vannamei*) is the first species produced in the world in economic value and the tiger shrimp (*Penaeus monodon*) and the Japonese shrimp (*Penaeus japonicus*) could also be, in a short period important species in the market. The interest of king crab and spider crab are also been recently investigated. Lobster programs of restocking are developed in several European countries. The culture of small crustaceans like copepods and *Palaemonetes* species will increase in the near future to be used as live prey for the rearing of high value ornamental species.

Sea urchin

Sea urchin roe (gonads) is a luxury food product consumed worldwide. Sea urchin is one of the major shellfish resources all over the world. Its commercial culture started primarily as a resource enhancement tool to address the severe depletion of the resource due to excessive fishing pressure of wild stocks. Some countries with overexploitation of the natural resource consider sea urchin as protected species (France, Greece and Croatia). *Paracentrotus lividus* is the most studied species but other new species as *Sphaerochinus granularis*, Strongylocentrotus nudus, and *Psammechinus miliaris* are being also recently considered. Hatchery conditions are known but larval survival at a commercial scale is in general low (around 5%). Recent data from Scotland, UK report values between 15 and 40% Ongrowing conditions in tanks and sea-based holding systems are described in the U.K., New Zealand and Norway. Different seaweeds species (*Ulva, Undaria, Sargassum* plants, etc.) are used to feed sea urchin species, but the main need to attain commercial level is to elaborate an artificial diet to substitute kelp and seaweeds species to growth juveniles until marketable size. This diet should produce an optimal roe with the best smell and colour for the market.

Ornamental species

Over the last decade marine aquarium trade has become a very high yield activity because the high market prices of ornamental species and their high demand worldwide. This activity heavily depend on the collection of wild individuals, mainly from coral reefs, but to maintain a more sustainable approach it is necessary to define aquaculture techniques to rear target species that suffer over-exploitation.

Marine aquarium fishes are currently produced in Europe using close recirculated systems. The most commonly reared fish are those of demersal spawners because the large size of the larvae produced (clownfish, dottybacks and gobbies). Rotifer, Artemia are frequently used as first prey for demersal species and calanoid copepods for pelagic ones. The culture of seahorses has experimented a significant improvement during last 5 years, especially on the broodstock and larval rearing conditions. Promising results suggest in the next few years a very higher number of new marine ornamental species in the trade (like green mandaring gobby, seahorses species, among others).

Stony corals are the more study group of invertebrates in Europe, but soft corals, ornamental shrimps and seas lags are also investigate.
Besides new species, the future trends of research have to be focus in determine techniques of differentiation between cultured and wild specimens (for example, colour differences) to effectively identify marine ornamental species and promote a sustainable marine aquarium trade instead the actual destructive fishing techniques commonly used.

Other groups

There is a wide-scale interest in developing intensive sea-cultivation of macroalgae species with the idea of supplying industry with food products, bioactive molecules or biodiesel production. In Europe kelp species (Laminaria) have focused the research advances. Laminarias have a heteromorphic life-cycle, alternating between microscopic small gametophytes and large sporophytes. For culture purposes the microscopic stages are carried out in laboratory, while the ongrowing is carried out on longlines at sea.
Some other species of molluscs such as razor-clams and haliotis or crustaceans like barnacles have recently been pointed out as species that could be produced for aquaculture. Despite their high interest, further works still have to be done in order to know more about the culture conditions of these species.
Turtles, frogs and other groups have been also investigated - focusing the research on the quality of the effluents released from the rearing tanks.